DEVONIAN AND EARLY CARBONIFEROUS POLYPLACOPHORA FROM WESTERN AUSTRALIA

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Three new taxa of polyplacophorans are described from the Carboniferous (Tournaisian) Septimus Limestone and Viséan Utting Calcarenite of the Bonaparte Gulf Basin, Western Australia. New taxa are *Gryphochiton collectus* sp. nov., *Compsochiton formosus* gen. et sp. nov. and *Harpidochiton auctus* gen. et sp. nov. A single plate representing *Arcochiton* Hoare & Sturgeon, 1976 is described from the Devonian Frasnian Sadler Limestone, Canning Basin, Western Australia. ❒ *Polyplacophora, Devonian, Carboniferous, Bonaparte Gulf Basin, Canning Basin, Western Australia.*

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Plates of Palaeozoic polyplacophorans have not been commonly reported from Australia. The first recorded occurrence was *Chelodes calceoloides* by Etheridge (1897), from the Upper Silurian of New South Wales (NSW). Iredale & Hull (1926) described a Permian taxon from NSW, *Permochiton australianus* and Farrell (1992) described *Chelodes intermedius* Bergenhayn, 1960 and *Helminthochiton* sp. nov. from the Early Devonian of NSW. The Devonian and Carboniferous specimens described herein from Western Australia (WA) add substantially to our knowledge of Palaeozoic Polyplacophora in the continent.

GEOLOGY AND AGE

The onshore Bonaparte Gulf Basin, WA, includes a number of Lower Carboniferous units which have yielded a rich and diverse fossil fauna. Those faunas studied include brachiopods, (Roberts, 1971; Thomas, 1971), conodonts (Druce, 1969) and ostracodes (Jones, 1989). Studies of molluscan elements of the Carboniferous faunas are now underway. The present work is concerned with polyplacophoran plates recovered from silicified faunas in the Utting Calcarenite on the northwestern shelf, and the Septimus Limestone on the eastern shelf of the onshore Bonaparte Gulf Basin. For a recent summary of the stratigraphy and regional geology see Mory & Beere (1990). A detailed biostratigraphic summary was provided by Roberts (1985).

The Septimus Limestone crops-out in the SE of the Bonaparte Basin and has been assigned a Tournaisian (latest Tn_2 to Tn_3) age, *Schellweinella australis* Zone to lower *Spirifer spiritis* Zone, primarily based on brachiopod faunas (Roberts, 1971). Chitons described from the Septimus Limestone are from the upper part of the unit and are hence regarded as Tn_3 in age. The Utting Calcarenite is a laterally restricted unit which crops out in the NW of the onshore basin and has been assigned a Viséan (V_{3b-c}) age, *Punctospirifer pauciplicatus* Zone.

In addition to the Carboniferous taxa, a new Late Devonian occurrence is described. The single plate was recovered from the Late Devonian (Frasnian) Pillara Limestone, in the Hull Range, Canning Basin, WA. All material is held in the Queensland Museum Palaeontology collections (QMF).

List of Localities. QML1095 Utting Calcarenite, Utting Gap, Ningbing Station, Bonaparte Gulf Basin, WA, 14°58.17'S, 128°35.82'E. Coll. A. Cook, P. Jell, May 1996; A. Cook, T. Smith, July 1998. QML1096 Septimus Limestone, low spur on NW side of Mt Septimus, Ivanhoe Station, Bonaparte Gulf Basin, WA, 15°42.5'S, 128°59.22'E. Coll. A. Cook, P. Jell, May 1996; A. Cook, T. Smith, July 1998. QML1160. Sadler Limestone, SW side of Paddy's Valley, SSE Wade Knoll, Canning Basin, WA, 18°40'07" S, 125°59'31"E. Coll. A. Cook, T. Smith. This is near Stop 2/Day 1 of Playford (1981).

RECONSTRUCTIONS

The reconstructions (Fig. 1) illustrate plate relationships in the three Carboniferous taxa described herein. Head plates are unknown for *Gryphochiton collectus* sp. nov. and *Harpidochiton*

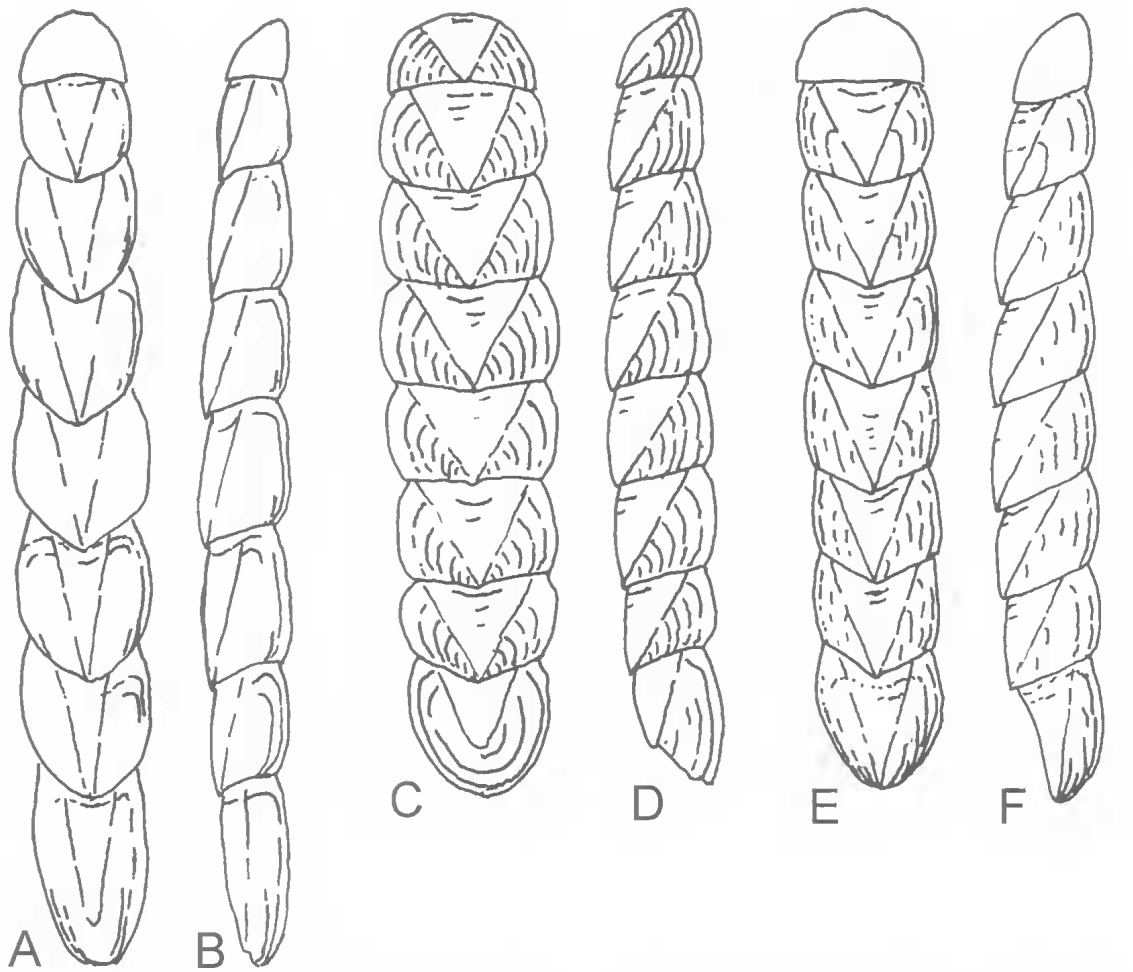


FIG. 1. Reconstructions. A, B, *Gryphochiton collectus* sp. nov., dorsal and right lateral views, approx. × 1.0. C, D, *Compsochiton formosus* gen. et sp. nov., dorsal and right lateral views, approx. × 1.0. E, F, *Harpidochiton auctus*, gen. et sp. nov., dorsal and right lateral views, approx. × 1.0.

auctus gen. et sp. nov., but the number of other plates present for each taxon allows some basis in forming arrangements as presented. No information as to size of girdle or presence of girdle spines or plates is present.

SYSTEMATIC PALAEONTOLOGY

POLYPLACOPHORA de Blainville, 1816
LEPIDOPLEURIDAE Thiele, 1910
GRYPHOCHITONIDAE Pilsbry, 1900
Gryphochiton Gray, 1847

Gryphochiton collectus sp. nov.
(Figs 1A,B, 2)

ETYMOLOGY. Latin, *collectus*, narrowed, contracted.

MATERIAL. HOLOTYPE: QMF51013, from QML1096, Septimus Limestone, Tournaisian, Bonaparte Gulf Basin. PARATYPES: QMF51014-51022 from QML1096.

DIAGNOSIS. Tail plate narrowly elongate; intermediate plate elongate, wider posteriorly than anteriorly, strongly arched.

DESCRIPTION. Plates of moderate size (Table 1). Tail plate elongate, narrow, strongly arched. Jugal area prominently set off from lateropleural areas, mucro small, just anterior to posterior margin. Posterior margin slightly arched; anterior margin straight. Sutural laminae relatively wide, long. Surface smooth with prominent comarginal growth ridges posteriorly and laterally. Angle of jugal area 20°.

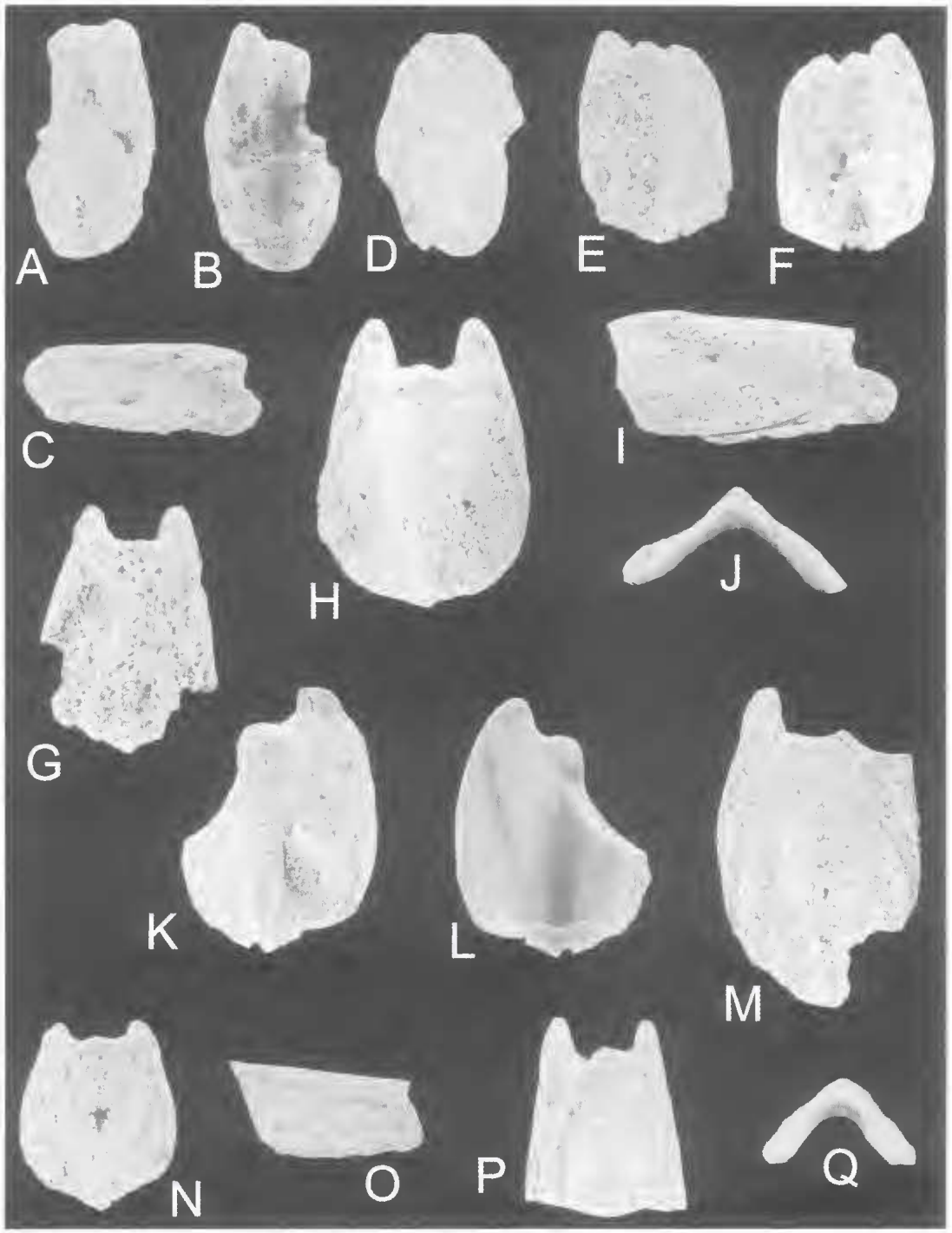


FIG. 2. *Gryphochiton collectus* sp. nov. A-C, Holotype QMF51013, tail plate, dorsal, ventral and right lateral views; D, Paratype QMF51020, tail plate, dorsal view; E,F, Paratype QMF51015, intermediate plate, dorsal and ventral views; G, Paratype QMF51018, intermediate plate, dorsal view; H-J, Paratype QMF51014, intermediate plate, dorsal, right lateral and posterior views; K,L, Paratype, QMF51016, intermediate plate, dorsal and ventral views; M, Paratype QMF51018, intermediate plate, dorsal and right lateral views; P,Q, Paratype QMF51019, intermediate plate, dorsal and anterior views. All ×2.5

TABLE 1. Measurements for *Gryphochiton collectus* sp. nov.

Specimen	Length (mm)	Width (mm)	Height (mm)	Plate
QMF51013*	13.5	7.8	2.4	T
QMF51014	16.0	12.5	5.9	T
QMF51015	12.9	9.2	3.9	T
QMF51016	14.9	11.6	5.4	T
QMF51017	18.5	11.8	5.5	I
QMF51018	13.7	10.2	4.7	I
QMF51019	10.6	9.2	4.3	I

Intermediate plates longer than wide, tapering anteriorly, strongly arched. Lateral margins gently convex, anterior margin straight to slightly convex, posterior margin slightly mucronate. Jugal area distinct from lateropleural areas. Apical area large, extending as broad band along posterior margin. Surface smooth with prominent comarginal growth ridges on lateropleural areas. Apical angle 94° to 112°, angle of jugal area 18° to 23°. Headplate unknown.

REMARKS. *Gryphochiton collectus* sp. nov., although smaller, is most similar to *G. nervicanus* (de Ryckholt, 1845), the type species of *Gryphochiton* Gray, 1847b. Comparisons were made with three tail plates and one intermediate plate of *G. nervicanus* in the collections of the Museum of Comparative Zoology, Harvard University. The major difference lies in the much larger sutural laminae, larger apical areas, and less strongly arched posterior margin of the tail plate in *G. collectus*.

Compsochiton gen. nov.

TYPE SPECIES. *Compsochiton formosus* sp. nov.

ETYMOLOGY. Greek, *kompsos*, elegant, pretty; *chiton*, tunic.

DIAGNOSIS. Tail plate with broadly angular jugum, posterior margin flatly convex and curved dorsally; intermediate plate mucronate; sutural laminae large.

DISTRIBUTION. Carboniferous (Tournaisian), Septimus Limestone, Bonaparte Gulf Basin, WA.

REMARKS. *Compsochiton* differs from *Gryphochiton* Gray, 1847a by having differentiation of jugal and lateropleural areas on the head plate, a small falsebeak on the tail plate, and lack of the subquadrangular to subrectangular shaped intermediate plates of the latter genus. *Euleptochiton* Hoare and Mapes, 1985, has a much wider than long tail plate with a narrower jugal area, and mucro located anterior to midlength.

Compsochiton formosus sp. nov.
(Figs 1C,D, 3)

ETYMOLOGY. Latin, *formosus*, beautifully formed.

MATERIAL. HOLOTYPE: QMF50123, from QML1096, Septimus Limestone, Tournaisian, Bonaparte Gulf Basin. PARATYPES: QMF50124-50136, from QML1096.

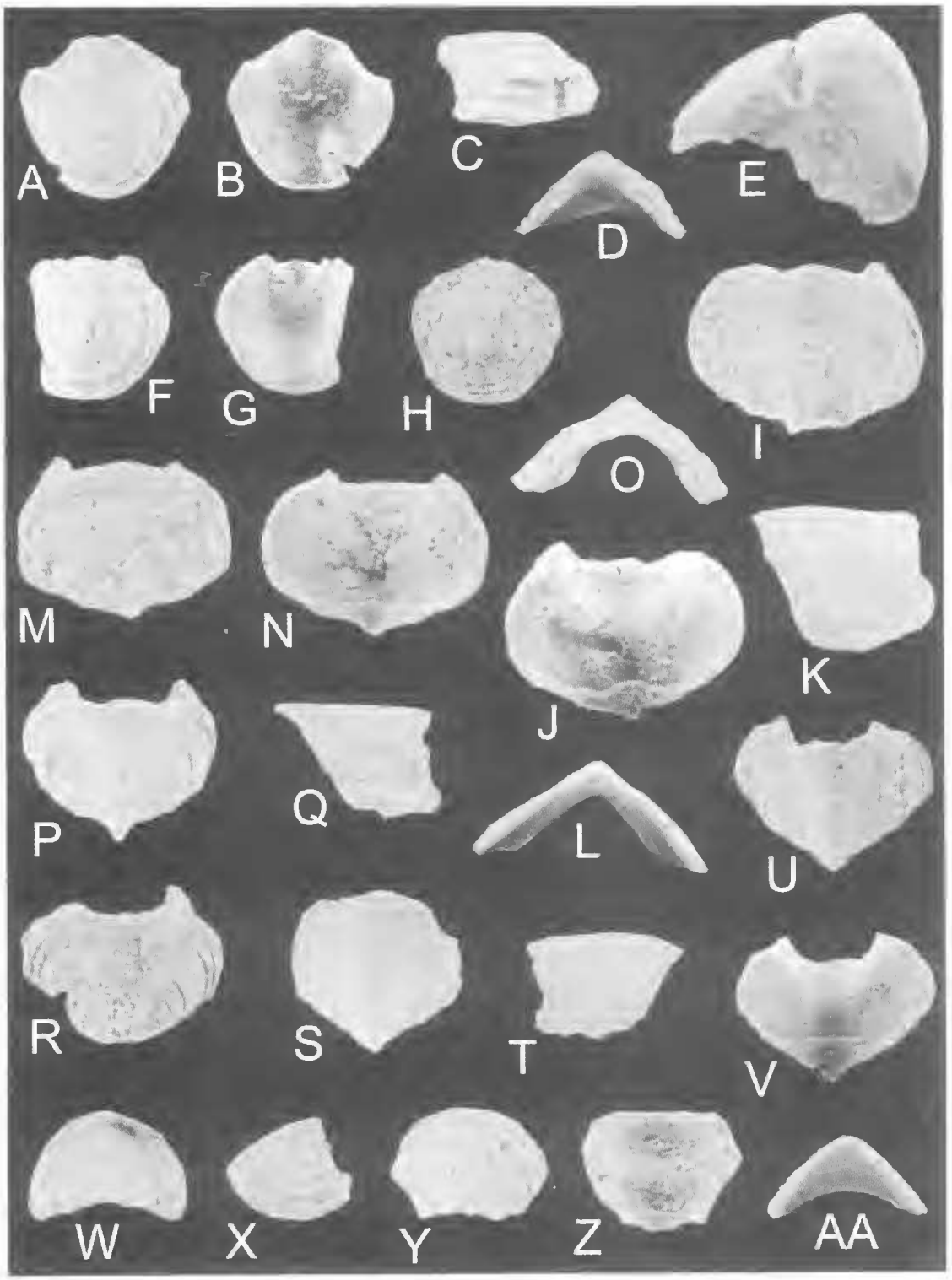
DIAGNOSIS. As for the genus.

DESCRIPTION. Plates of moderate size (Table 2). Tail plate strongly arched with broadly angular jugal area, mucro low and posterior to midlength. Posterior margin flatly convex, lateral margins diverging anteriorly, anterior margin with small false beak. Jugal area slightly set off from lateropleural areas, the latter marked by distinct comarginal growth ridges. Sutural laminae wide, long, extending to anterolateral corners. Surface ornamented with fine, closely spaced pustules. Angle of jugal area 70°.

Intermediate plates wider than long, strongly arched, with broadly angular jugal area, slightly to distinctly set off from lateropleural areas. Posterior margin mucronate, lateral margins convex, anterior margin ranging from slightly convex to slightly concave. Apical area large medially, extending as narrowing band to posterolateral corners. Surface with fine, closely spaced pustules and distinct comarginal growth ridges on lateropleural areas. Apical angle 93° to 106°, angle of jugal area 48° to 60°.

Head plate strongly arched with broadly angular jugal area distinct from lateropleural areas.

FIG. 3. *Compsochiton formosus* gen. et sp. nov. A-E, Holotype QMF51023, tail plate, dorsal, ventral, left lateral, anterior and oblique ventral views; F,G, Paratype QMF51024, tail plate, dorsal and ventral views; H, Paratype QMF51026, tail plate, dorsal view; I-L, Paratype QMF51028, intermediate plate, dorsal, ventral, right lateral and posterior views; M-O, Paratype QMF51027, intermediate plate, dorsal, ventral and anterior views; P,Q, Paratype QMF51029, intermediate plate, dorsal and right lateral views; R, Parataype QMF51030, intermediate plate, dorsal view; S,T, Paratype QMF51031, intermediate plate, dorsal and left lateral views; U,V, Paratype QMF51033, intermediate plate, dorsal and ventral views; W,X, Paratype QMF51034, head plate, dorsal and left lateral views; Y-AA, Paratype QMF51035, head plate, dorsal, ventral and posterior views. All ×2.5 exeept E ×4.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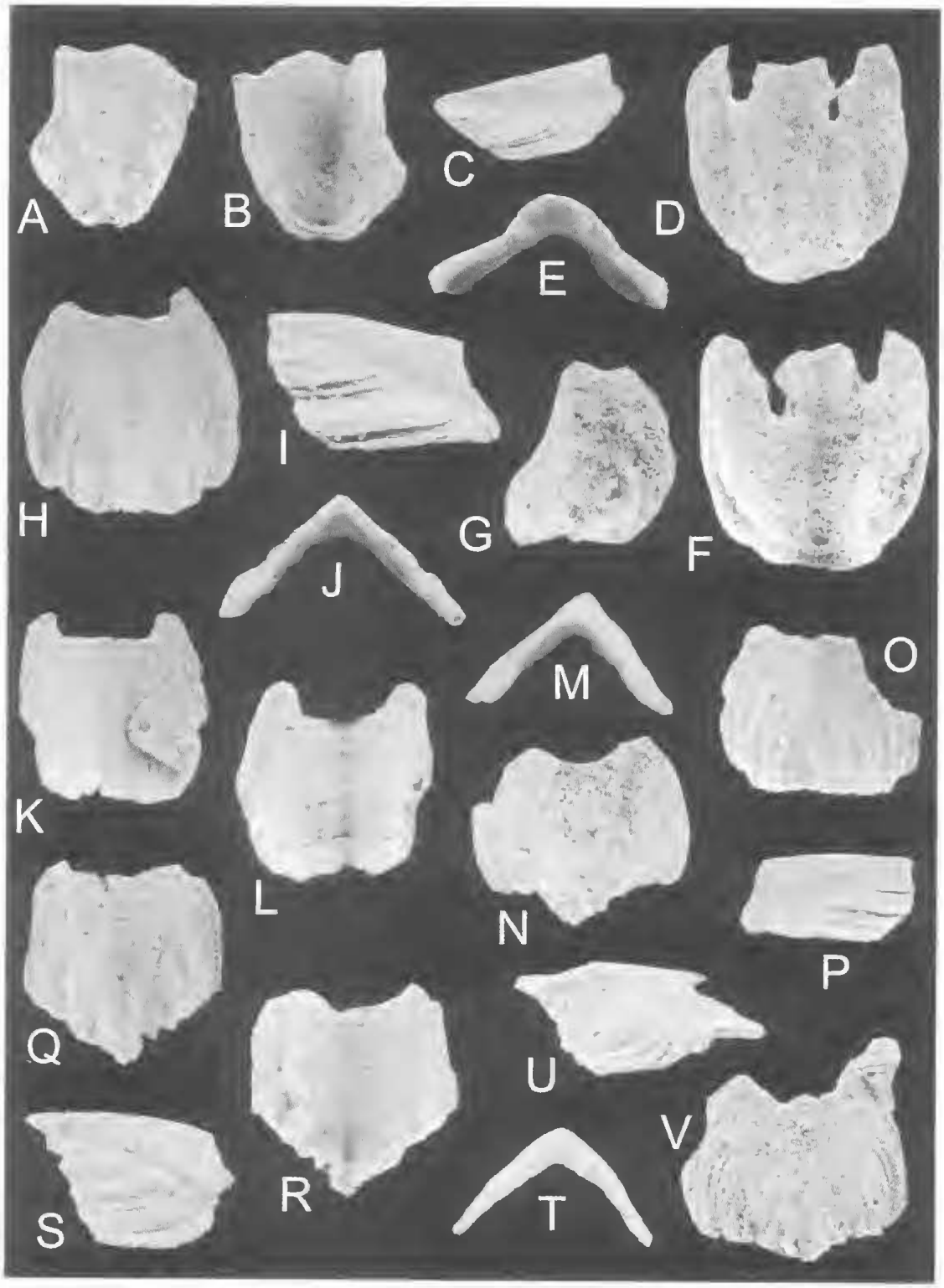
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TABLE 2. Measurements for *Compsochiton formosus* gen. et sp. nov.

Specimen	Length (mm)	Width (mm)	Height (mm)	Plate
QMF50123*	9.8	9.7	5.2	I
QMF50124	9.4	9.0	3.8	I
QMF50125	8.7	9.0	4.2	I
QMF50126	8.7	8.7	4.7	I
QMF50127	9.8	12.6	5.5	I
QMF50128	10.3	14.0	6.7	I
QMF50129	9.5	11.1	5.1	I
QMF50130	9.8	11.4	5.6	I
QMF50131	10.3	9.9	5.2	I
QMF50132	9.8	12.0	5.8	I
QMF50133	8.8	11.2	5.3	I
QMF50134	6.3	9.2	5.1	H

Anterior and lateral margins broadly curved, posterior margin nearly straight. Apical area large, extending along posterior margin to posterolateral corners. Surface with fine pustules and distinct comarginal growth ridges in latero-pleural areas. Apical angle 106°, angle of jugal area 60°.

REMARKS. At first appearance *C. formosus* looks similar to *Gryphochiton parvus* (Stevens, 1858), although the plates are three times the size of the latter species. Other than size, the distinct, broadly angular, jugal area, large sutural laminae, false beak on the tail plate, and the finely pustulose ornamentation on *C. formosus* clearly differentiate the two taxa.

INJURY. The holotype of *Compsochiton formosus* gen. et sp. nov., a tail plate, has an injury in the posterolateral margin (Fig. 3B, C, E). A notch, approximately 0.75mm wide and 1.5mm high, extends through the shell material. It is evident that the chiton was alive at the time of the injury by the presence of new shell material deposited on the ventral surface to block off the opening. No indication is present as to the cause of the injury although the bulging inward shape of the repair made by the individual would indicate that either the mantle at the site had been injured or that the predator was present within the notch in the original shell layers. This is the first example of plate injury and repair of a fossil polyplacophoran that we are aware of.

LEPIDOPLEURIDAE? Pilsbry, 1892

Harpidochiton gen. nov.

TYPE SPECIES. *Harpidochiton auctus* sp. nov.

ETYMOLOGY. Greek, *harpidos*, shoe or sandal; *chiton*, tunic.

DIAGNOSIS. Tail plate subtriangular, longitudinally concave, mucro terminal; intermediate plates subquadrangular, strongly arched, apical area large.

DISTRIBUTION. Carboniferous (Tournaisian), Septimus Limestone, Bonaparte Gulf Basin, Western Australia; (Viséan) Utting Calcarenite, Bonaparte Gulf Station, WA.

REMARKS. *Harpidochiton* differs from genera of the family Acutichitonidae Hoare, Mapes & Atwater, 1983, also with subtriangularly shaped tail plates, by lacking a hypotyche on the ventral surface. *Systenochiton* Hoare (in press), from the Mississippian (Osagean) of Iowa lacks the longitudinal concavity in the subtriangular tail plates, has a subcentral mucro, and has much smaller sutural laminae than is present in *Harpidochiton*.

The characters of *Harpidochiton* do not conform well with those of the other lepidopleurids, nor with other described families. It is assigned here temporarily pending additional material on which to base a new family.

Harpidochiton auctus sp. nov.
(Figs 1E, F, 4)

MATERIAL. HOLOTYPE: QMF50137, from QML1096, Septimus Limestone, Tournaisian, Bonaparte Gulf Basin. PARATYPES: QMF50138-50144, from QML1096, QMF40826-40829, from QML1095, Utting Calcarenite, Viséan, Bonaparte Gulf Basin.

DIAGNOSIS. As for the genus.

DESCRIPTION. Plates of moderate size (Table 3). Tail plate subtriangular. Lateral margins convex, anterior margin straight to weakly convex.

FIG. 4. *Harpidochiton auctus* gen. et sp. nov. A-C, Holotype QMF51037, tail plate, dorsal, ventral and left lateral views; D-F, Paratype QMF51038, tail plate, dorsal, anterior and ventral views; G, Paratype QMF51039, tail plate, dorsal view; H-J, Paratype QMF51040, intermediate plate, dorsal, right lateral and posterior views; K-M, Paratype QMF51041, intermediate plate, dorsal, ventral and anterior views; N, Paratype QMF51043, intermediate plate, dorsal view; O,P, Paratype QMF51042, intermediate plate, dorsal and left lateral views; Q-T, Paratype QMF40826, intermediate plate, dorsal, ventral, right lateral and posterior views; U,V, Paratype QMF48027, intermediate plate, right lateral and dorsal views. All ×2.5.

TABLE 3. Measurements for *Harpidochiton auctus* gen. et sp. nov.

Specimen	Length (mm)	Width (mm)	Height (mm)	Plate
QMF50137*	10.9	11.0	5.9	T
QMF50138	13.8	13.2	7.9	T
QMF50139	10.8	12.1	7.9	T
QMF50140	13.7	13.1	7.9	T
QMF50141	11.6	11.2	6.0	I
QMF50142	10.7	12.3	5.6	I
QMF50143	11.1	12.9	6.5	I

Jugal area set off from lateropleural areas by pronounced grooves; mucro terminal. Lateral profile longitudinally concave. Sutural laminae large. Surface smooth with strongly developed comarginal growth ridges on lateropleural areas. Angle of jugal area 33°.

Intermediate plates subquadrangular, strongly arched, sharply curved transversely in jugal area. Lateral margins gently convex, anterior margin with wide, shallow jugal sinus, posterior margin straight to slightly mucronate. Jugal area prominent, set off by grooves. Sutural laminae large, extending to anterolateral corners. Apical area large, extending to posterolateral corners, often marked by comarginal growth ridges. Surface smooth with prominent growth ridges on lateropleural areas. Apical angle 93° to 103°, angle of jugal area 35° to 39°. Head plate unknown.

REMARKS. The concavity of the tail plate, the smooth surface, and the coarse, comarginal growth ridges restricted to the lateropleural areas are diagnostic of *H. auctus*.

ACUTICHITONIDAE Hoare, Mapes & Atwater, 1983
Arcochiton Hoare & Sturgeon, 1976

Arcochiton sp.
(Fig. 5)

MATERIAL. One tailplate QMF39839 from QML1160.

DESCRIPTION. Small (3.2mm long, 3.3mm wide, 2.4mm high) tail plate, subtriangular in dorsal and lateral views. Jugal area narrow, slightly set off from steep lateral slopes, mucro terminal posteriorly. Anterior margin with deep jugal sinus, large, well-developed hypotyche on ventral surface. Surface granulose, augmented by silica replacement, especially near lateral margins. Evidence of narrow sutural laminae on ventral surface paralleling margins of jugum, their projections not preserved.

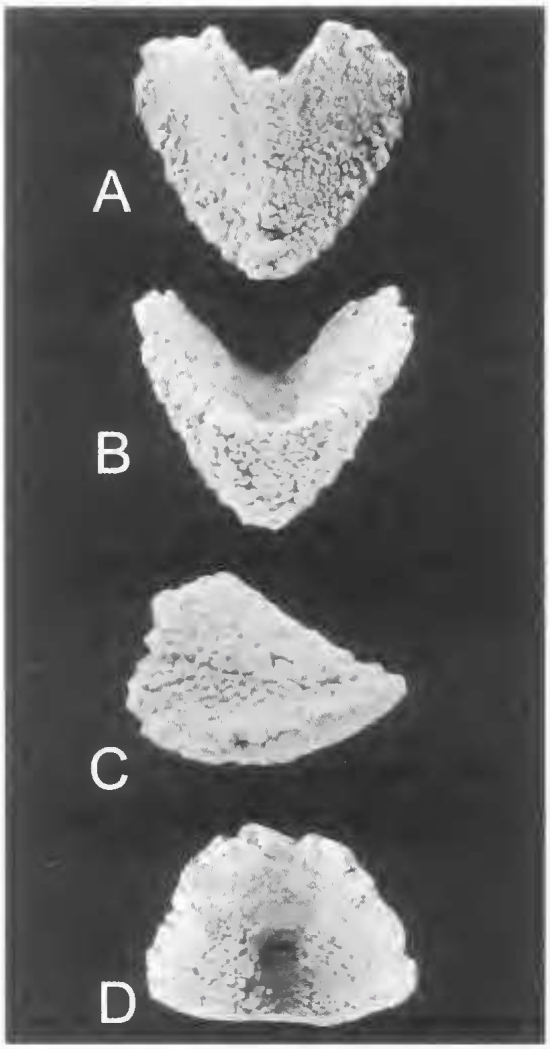

FIG. 5. *Arcochiton* sp. A-D, Hypotype QMF39839, tail plate, dorsal, ventral, left lateral and anterior views. All ×10.

REMARKS. The presence of this Australian specimen extends the known range of the family Acutichitonidae from the Pennsylvanian to the Upper Devonian and specimens from Oregon further extend that range into the Permian (Hanger et al., 2000). The coarse preservation partially masks the characters of the plate. The shapes and curvature of the plate and hypotyche are distinctive of *Arcochiton*. More and better preserved material would allow the establishment of a new species.

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